Pneumatic Ball Propulsion Apparatus

This application is a continuation-in-part of Serial No. 09/999,205 filed November 30, 2001, the disclosure of which is incorporated herein by reference.

Background of the Invention

The present invention is directed to an apparatus for pneumatic propulsion of a ball. Further, the present invention provides an apparatus that is capable of propelling a ball pneumatically with high accuracy at speeds useful for baseball and softball batting training and the like. The present invention also allows spin to be imparted to a pneumatically-propelled ball.

Devices that propel a ball by means of a mechanical arm or rotating disks generally have been used for baseball and softball training. These devices have not been satisfactory in providing high-speed propulsion with sufficient accuracy. Devices that use pneumatic propulsion for tennis training also have been known. These also have not been sufficiently accurate for baseball and softball training. In addition, past devices have not had the capability of imparting spin to a projected ball reliably, thereby limiting the ability of the devices to provide training conditions that fully correspond to situations actually faced by participants in sports like baseball, softball and tennis.

Summary of the Invention

The present invention provides an apparatus capable of projecting a ball pneumatically with sufficient accuracy, e.g. for baseball and softball training purposes. The present invention further provides an apparatus that allows fine adjustments in the direction in which a ball is propelled. The present invention further provides an apparatus capable of imparting spin to a pneumatically projected ball. The present invention further provides an apparatus that is capable of adjustment of the speed at which a ball is projected pneumatically. The present invention further provides an apparatus that is capable of projecting a ball at a velocity of at least 90 mph (145 kph), preferably at least 100 mph (160 kph) using a single blower motor requiring no more than

15 amps of power. The present invention further provides training methods that make use of one or more of the various aspects of apparatus that are discussed above.

The invention is described in more detail below. The present invention is not limited to the specific embodiments described below. Modifications will be apparent and are intended to be encompassed by the present invention.

Brief Description of the Drawings

Fig. 1 is a perspective view of a ball propulsion device according to an embodiment of the present invention.

Fig. 2 is a perspective view of a ball propulsion device according to another embodiment of the present invention.

Figs. 3A is a sectional view of an aim adjusting element useful with the present invention, while Figs. 3B and 3C are perspective views of members that are used in the aim adjusting element.

Fig. 4A is side view of a spin imparting element useful with the present invention, while Figs. 4B and 4C are top and side views of one of its pieces.

Fig. 5A is a top perspective view of support platform for a ball propulsion device and Fig. 5B is a bottom perspective view thereof. Fig. 5C is a top perspective view of a second embodiment of the support platform.

Fig. 6A and 6B are side and front perspective views of a ball propulsion device according to another embodiment of the present invention.

Fig. 7 is a side view of a ball propulsion device according to another embodiment of the present invention.

Detailed Description

The present invention will be described below with reference to the accompanying drawings. The present invention is not limited to the specific aspects of the invention discussed below.

The general configuration of a pneumatic ball propulsion apparatus according to the present invention is illustrated in Figs. 1 and 2. Referring to Fig. 1, the apparatus 10 includes a hopper 12 that contains balls (or other projectiles) to be propelled, and a pressure canister 13 to which a blower is connected for supplying air to the interior of the canister. The blower can be connected to a convenient power source to supply electricity to the blower motor. The canister is provided with an exit tube 14, through which a ball is expelled after the canister is pressurized. The inner diameter of the exit tube generally will be about the same as or only slightly larger than that of the ball being propelled. The angle of the exit tube can be changed to adjust the trajectory of the expelled ball. The balls in the hopper are delivered to the interior of the canister one-by-one with a rotating carousel that has apertures for accepting and carrying individual balls. The carousel delivers the ball to a tube, through which the balls are fed by gravity to the interior of the canister. If desired, provision can be made for automatic delivery of projectiles from the hopper to the canister at regular intervals, for "on-demand" delivery of projectiles from the hopper to the canister, e.g. by permitting remote control operation of the carousel. The same device can be capable of either mode of delivery. In addition, projectile delivery intervals can be controlled by blocking certain of the projectile-accepting holes in a rotating carousel. For example, blocking every other hole will double the interval between projectile deliveries.

The apparatus in Fig. 1 generally will be set on the ground. The apparatus needs to maintain the proper orientation to deliver balls from the hopper to the carousel and from the carousel up to and through the delivery tube. The legs supporting the canister can be made adjustable to accommodate unevenness of the ground. In addition, the legs of the hopper can be made adjustable in order to allow the hopper to maintain the proper orientation for delivering balls to the canister. Further, a support for the apparatus, discussed below, can be provided with a step that accommodates some unevenness of the ground. The capability for elevation adjustment also can be built into the rear base of the apparatus.

In use, balls to be propelled are delivered from the hopper to the interior of the canister through a tube, and carried to the exit tube. The exit tube is provided with a resilient seal that is capable of expanding radially outward, which engages the ball to be

propelled. The seal may be in the shape of a ring and holds the ball in place during pressurization of the canister. The seal may be in the form of a ring-shaped rubber member held within the tube, acting as a barrier to the passage of the ball or other projectile

The continued supply of air to the canister causes pressure to build behind the ball, which in turn increases the force applied to the seal by the ball. When the force applied by the ball exceeds the resilient force of the seal, the inner surface of the seal is forced outward. When the inner surface of the seal is forced outward sufficiently to permit the ball to pass, the ball is expelled through the exit tube by the compressed air in the canister. Devices that use this principle for the pneumatic propulsion of tennis balls are known, for example devices marketed by "LobSter"™, and therefore more detailed description of their operation is omitted.

The air pressure and volume accumulated behind the ball when it is expelled from the exit tube determine the speed at which the ball is propelled. This can be varied by changing the characteristics of the seal, e.g. dimensions and/or materials. In addition, different capacity blowers, multiple blowers and/or larger canisters can be used as necessary to provide sufficient air pressure and volume for the desired speed. The canister can have a cylindrical shape, but other shapes can be used if desired. An example of useful dimensions for the canister are a diameter of about 10-16 inches, preferably about 11 inches and a length of about 14-24 inches, preferably about 16 inches. The canister generally will have a volume of at least about 1200 cc, preferably at least about 1500 cc. Such volumes are useful for projecting balls and the like at speeds suitable for sports training, such as for baseball training at a collegiate level or higher. For practical reasons of portability and handling, it is desirable if the maximum volume is less than about 3500 cc, preferably less than about 2500 cc. The present invention may be applied readily to other pneumatic ball propulsion systems that make use of an exit tube and is not limited to the system described above.

The exit tubes for pneumatic ball propulsion systems typically have exit tubes that are no more than about 21 inches (53cm) in length. For the present purposes, this length is determined as the distance from the point at which the ball is released (the seal location in the above embodiment) to the exit end of the tube. While this may provide sufficient

accuracy for purposes such as tennis, it may not provide sufficient accuracy at higher speeds for purposes such as baseball and softball training, where location accuracy on the order of a few inches (cm) or less at a distance of 40 feet (13m) or more (about 54 feet (17m) in the case of simulating a release point for baseball training) is desired.

In order to provide improved accuracy and speed, an apparatus in one aspect of the present invention uses an extension tube 16. The extension tube 16 preferably is secured to the exit tube 14 with a seal 17, for example a lock pin seal, to provide a substantially airtight connection. Clamps, tapped connections, threaded connections, tape and other devices can be used as appropriate. Alternatively, the exit tube 14 can be formed of a sufficient length to provide the desired accuracy and velocity. The length necessary for achieving a particular accuracy will change depending on the speed of the balls. For purposes of ball speeds in a range of about 40-65 mph (about 65-105 kph), the exit tube length should be at least about 15 inches (about 35 cm), preferably at least 20 inches (about 50 cm). The extension tube 16 illustrated in Fig. 1 has a length of about 21 inches (about 53 cm), and provides an exit tube length of about 27 inches (about 68 cm). For higher ball speeds, longer exit tube lengths are necessary. For example, for ball speeds as high as 75 mph or 90 mph (120 kph or 145 kph) or more, an exit tube length of 4 feet (1.3m) or more may be needed. For example an extension tube 18 in Fig. 2 has a length of about 4.5 feet (1.5 m). Generally, the exit tube should be the shortest length that provides the desired accuracy and speed, as an excessive tube length can cause ball speed to drop. It is desirable to optimize the exit tube length with respect to speed and accuracy for the intended application.

In a preferred embodiment, the exit tube will have a length from 2.5 feet (0.8m) to 5.5 feet (1.7m), particularly 3 feet (1m) to 5.5 feet (1.7m), more particularly 3 feet (1m) to 5 feet (1.5m), and more particularly 4 feet (1.3m) to 5 feet (1.5m). This is especially useful for baseball training.

It also may be desirable to use an exit tube whose exit end has a color that provides an enhanced visual focal point for someone using the apparatus for training. For example, the exit end, and particularly the end face of the tube facing the user, could be painted (or otherwise colored) in a fluorescent red color. Other colors might be used if desired.

For high level training, especially in sports such as baseball or tennis, and which can include vision training, it is desirable to project a ball at speeds of about 100 mph (160 kph) and higher. While it is possible to achieve speeds of about 140 mph (220 kph) and higher with a reasonably practical canister size by using multiple blower motors, this suffers from practical drawbacks in terms of requiring special electric circuitry or dual wires to separate power sources on different circuits, and renders such apparatus useful only in relatively specialized applications. Therefore, in one aspect of the present invention, the ball projecting apparatus is capable of projecting a ball at a speed of at least 100 mph (160 kph), for example in a range from about 50 mph to 105 mph (80 to 170 kph) and makes use of a single blower requiring no more than 15 amps of current. An example of a suitable blower is the Ametek Model 117500-12 blower available from Lamb Electric of Kent Ohio, which is a 7.2 inch (183 mm) fan diameter three-stage tangential bypass discharge blower that can operate on a typical "house" voltage of 120 volts, drawing no more than 15 amps of current. Such a blower has a maximum airflow of about 102.5 cfm for general motor performance and is capable of supplying a canister discussed above with a pressure of about 4-7 psi, preferably about 5-7 psi, more preferably about 5-6 psi, which is sufficient to propel a tennis ball-sized projectile at a speed of over 100 mph (160 kph) at the volumes noted above. The use of a single motor blower drawing less than 15 amps of current is particularly useful for in baseball and softball training.

It is possible to allow for changing the ball speed for a given tube length by providing selectively openable apertures on the exit tube. Opening an aperture on the exit tube results in the loss of some of the compression, thereby decreasing the ball speed. When a plurality of such apertures is provided, the options for varying ball speed increase. Opening more apertures, or increasing the effective size of an aperture, reduces the ball speed more. A short tube piece with selectively openable apertures can be used to provide the option of speed variation as an add-on feature. The selectively openable apertures also could be in the form of one or more simple holes that can be covered selectively by an operator, for example using finger(s). For example, this allows for simulation of change-ups and other off-speed pitches for baseball or softball training.

The embodiment of Fig. 2 shows an apparatus that is elevated. The apparatus 10 may be supported on a ladder-like device 20. A tripod 22 may be used to support the end of the extension tube 18. This configuration is advantageous in that the ball exit point is similar to the point where a baseball would be released when thrown by a pitcher. The height and angle of propulsion can be varied as desired, e.g. to simulate a ball thrown from a pitcher's mound. While the apparatus 10 is set on a platform in Fig. 2, it would be possible to provide adjustable legs or the like as part of the apparatus 10 itself, or a tripod-like support structure with adjustable elevation (e.g. by a crank) could be used for more convenient transport. A step-up device like a ladder is useful because it facilitates access to the propulsion device, e.g. to clear jams. Ladders such as the Costco Prodeck III ladder or the Costco Pro Fold Deluxe ladder are examples of useful devices. It may be necessary to provide a platform, for example one as shown in Figs. 5A-C discussed below, to provide proper support for the apparatus. When the apparatus is elevated, it may be useful to provide one or more viewing apertures in the sidewall of the hopper 12, which allows an operator to assess the status of projectiles in the hopper, e.g. number remaining, possible misfeeding, etc. The viewing aperture may be on the order of 0.75 to 2 inches (2 to 5 cm) in diameter, preferably about 2 inches. The apertures can be open or covered with a transparent material if desired.

Elevating the apparatus 10 may be useful for other types of training besides baseball training. For example, an elevated apparatus could be used to simulate a tennis serve. This generally would require more elevation than for baseball training, and the elevation can be selected as appropriate for a particular activity.

A position adjuster 38 (Figs. 3A-C) may be provided to permit close control over the direction of the propelled ball. In one embodiment, the position adjuster 38 can include a first member 40 and a second member 42 that is capable of relative movement with respect to the first member 40 to permit position adjustment, and also is capable of being secured to the first member 40 to prevent relative movement. It is desirable to provide finger tip and pinpoint control. The second member 44 is adapted to engage the exit tube (or an extension tube) of the apparatus 10. In the illustrated embodiment, this is accomplished by providing a U-shaped cut-out in the second member 44. The exit tube or extension is carried in the cut-out. Other engagement systems can be used as desired.

One example of a system permitting the relative movement between the first and second members is illustrated in Figs. 3A. In this embodiment, the first member 42 is provided with a T-shaped slot 42. A fastening member 48 has a head that is engaged in the slot 44, and extends through an aperture 46 in the first member 44. As one example, the fastening member may have a threaded end, and a threaded bolt 50 engages the threaded end of the fastening member. The bolt may take the form of a knob, wing nut or the like for ease of operation by hand, and the term bolt is intended to cover structures of this general type. The bolt can be tightened to secure the first and second members together and can be loosened to permit movement between the two, i.e. by virtue of the fastening member sliding in the slot.

The direction of position adjustment is determined by the orientation of the slot. In the embodiment Fig. 1, the slot is oriented vertically to permit fine control of the height of the end of the extension attached to the exit tube. In the embodiment of Fig. 2, the slot is oriented horizontally to permit fine control of the ball projection direction. The illustrated embodiment of Figs. 3A-C can be considered to be infinitely adjustable. Other infinitely adjustable systems may be suitable, or systems that have step-wise adjustment also may be useful.

The first member 40 is provided with a suitable support. In the case of an embodiment like that of Fig. 1, the first member 40 is provided with an appropriate base that rests on the ground. In the case of an embodiment like that of Fig. 2, the first member is carried by a device such as a tripod, which can be used to provide vertical adjustability.

The illustrated embodiment permits adjustment in one direction. However, it is possible to apply this aspect of the present invention to a system that permits adjustment in two directions. For example, a first member 40 provided with a horizontal slot could in turn be provided with an aperture that accepts a fastening member extending from a vertical slot carried by a third member that is otherwise essentially identical to the first member.

The first and second members of the position adjuster may be made of any suitable material, such as plastic, wood, metal, ceramic, etc. A metal member may be used to define the slot in the first member if desired. For example, a metal member of the

desired cross section may secured to a slot in the first member. It should be noted that the position adjuster can be adjusted by hand or driven, e.g. with motor-driven gearing or a motor-driven rack and pinion arrangement, or pneumatically, e.g. with compressed air taken from the canister. Remote control of the position adjuster may be useful in some cases.

Another aspect of the present invention permits a spin to be imparted to a pneumatically-propelled ball. An example of this aspect is illustrated in Figs. 4A-C. In this embodiment, at least one engaging member 26 is provided at an exit end of an exit tube, and has a portion that extends into the ball ejection path from the exit tube. The engaging member briefly grips the ball as it is expelled from the exit tube, thereby imparting spin to the ball. By imparting spin to the ball, it is possible to simulate pitches like a curve ball, slurve ball or slider, or to provide more realistic practice situations for other ball sports like tennis.

It is preferred to provide more than one, and more preferably two, engaging members in order to impart spin with greater certainty and reproducibility. In one aspect of the invention, two independent engaging members are provided. This allows the ready and independent adjustment of the spacing between the engaging members and pressure applied by the engaging members, thereby permitting variation in the nature of the spin imparted to the ball. However, the engaging members instead may be joined together if desired. In addition, the engaging members may be formed integrally with the tube end.

The engaging members may be mounted directly on the exit end of the exit tube if desired. However, if the engaging members are mounted on a separate tube that itself is secured to the exit tube, there are advantages through the ability to change the direction of the spin imparted to the ball. Thus, in this embodiment, two engaging members 26 are mounted on a tube 28 with clamps 30 to provide a spin adapter assembly 24. The clamps 30 may be of a screw hose clamp type, for example. The tube 28 can be configured to cooperate with the exit end of the exit tube in any suitable manner. For example, a clamping sleeve that fits over both the end of the end of the tube 28 and the end of the exit tube, and preferably is provided with separate clamping members such as screw hose clamp mechanisms at both ends of the sleeves, can be used. Loosening the clamping mechanism at the tube 28 side permits relative rotation between the tube 28 and the exit

tube, which changes the circumferential position of the engaging member(s) with respect to the exit tube, and permitting the ready variation in the direction of spin imparted to the ball. This makes is possible to simulate different game situations easily.

Providing the engaging member(s) on the tube 28 also has the advantage of readily imparting or not imparting spin to the ball as desired, i.e. by including the tube 28 in or removing the tube 28 from the exit tube assembly as desired. When the engaging member(s) is mounted on a separate tube 28, the tube 28 preferably will be relatively short, e.g. on the order of about 4 inches (10cm), so that the tube 28 does not affect the ball propelling properties of the exit tube significantly. The inner diameter of the tube 28 should correspond to that of the exit tube.

The engaging members preferably are stiff and resilient enough to engage the projected ball sufficiently to impart spin but without significantly impeding the propulsion of the ball from the exit tube or changing the ball's direction (other than through the action of the spin during the ball's flight). The nature of the materials forming the engaging members, the amount by which the engaging member extends into the ball exit path, and the angle at which the ball contacts the engaging member, i.e. the amount of hook at the end of the engaging member, can be selected appropriately to achieve this. It is desirable that the engaging members be bendable to permit changes in their configuration, thereby facilitating the changes in the spin imparted to the projected ball.

In one example, the engaging members are formed from a resilient and bendable metal core 32 and a flexible sleeve 34, for example made of a flexible rubber. In one example, the metal core can be 3/8 inch outer diameter (about 1cm) copper pipe. The rubber sleeve may be 5/8 inch outer diameter (about 1.7cm) flexible reinforced rubber tubing, such as that used for fuel lines.

It is desirable that part of the metal core be exposed, as this will permit more secure connection between the engaging member and the tubular member on which the engaging member is mounted. When the copper pipe is used as the metal core, the exposed end can be flattened to provide additional security in the connection. It may be desirable to have the rubber sleeve extend beyond the end of the metal core. In one embodiment, the rubber sleeve extends about 2 inches (5cm) beyond the free end of the

metal core. The rubber sleeve can be provided with lateral grooves 36 to improve the gripping of the ball to impart spin. Also, a soft, absorbent abrasive may be incorporated in the ball-contacting surface to improve the gripping. For the present purposes, the indication that a sleeve or covering extends beyond the end of the core should be understood to mean that the end of the sleeve or covering is beyond the end of the core by a distance greater than the thickness of the material forming the covering or sleeve along the length of the core.

A further aspect of the present invention, illustrated for example by Figs. 5A-C, provides a platform for the apparatus 10 that can engage a ladder-type support. The platform 52 has a support surface 54, on which the apparatus 10 will sit during use. The support surface is surrounded by a lip 56, which inhibits movement of the apparatus off of the support surface 54 due to vibration and the like. If desired, the support surface 54 can be provided with a low shelf upon which one set of legs of the apparatus can rest, which can help provide the desired orientation to the apparatus when it is sitting on the support surface.

Referring to the bottom view of Fig. 5B, blocks 60 are provided for engaging a ladder-like device on which the platform 52 is to be mounted. One or both of the blocks 60 may be adjustable with respect to each other. In the embodiment of Figs. 5A and B, both blocks 60 are carried in grooves 58. An individual block is carried by a parallel pair of grooves. A threaded fastener may be used, which engages the sidewalls of the groove and extends through the block 60. A bolt similar to that discussed above for Figs. 3A-C may be used to tighten the block in place or loosen it for adjusting movement. The sidewalls of the groove may be recessed so that the fastening member does not extend above the level of the support surface 54.

When both blocks are adjustable, the degree of adjustment and utility of the platform with different devices is increased. However, when more limited adjustability is acceptable, only one of the blocks may be adjustable. For a platform that is intended for a specific application, it may be acceptable to have both blocks fixed. The blocks may be provided with horizontal lips to provide more secure engagement with a ladder-type device, but this can reduce the usefulness of the platform with a variety of different devices.

In many cases, it is desirable for the apparatus 10 essentially to be centered on the platform. For some specific applications, for example depending on the configuration of the structure on which the platform is to be mounted, there may be some advantage in having the apparatus positioned closer to one side. An example of this is shown in Fig. 5C. In this embodiment, a support surface 62 extends beyond the area for the apparatus 10, which is defined by the lip 56. In this embodiment, only a single adjustable block 60 is provided. The other block is fixed, for example near the edge of the support surface 62 outside of the lip 56. In particular, the use of a support structure that carries the apparatus in an off center relationship to the crown of a ladder might be useful in reducing the chances of immediate collapse or falling of the ladder in the event of failure of the ladder's support at the end of the platform. That is, if the apparatus is positioned so that more weight is on the side of the crown opposite to a side that is supported by arms from the ladder, there is less likelihood of an immediate downward collapse should one or both of the arms fail, fail to lock properly, etc.

As exemplary dimensions useful for a platform to support a "LobSter" pneumatic ball propulsion device, the support surface 54 may be about 17.5 inches square (about 44cm). The lip may be about 2 inches (5cm) high. An extended support surface 62, for example useful with the Costco Prodeck III ladder or the like, is about 23 inches by 19 inches (57cm by 47cm). The area within the lip 56 is about 12 inches by 19 inches (30cm by 47cm). If both blocks 60 are adjustable, providing a range of spacing between the blocks 60 from about 13 inches to 19 inches (32cm to 47cm) is suitable for use with a wide variety of ladder-like devices. The blocks 60 may be about 3 inches high (7.5cm).

The various aspects of the pneumatic ball propulsion apparatus are useful in training methods for sports making use of a ball, such as baseball, softball, tennis and cricket, particularly for baseball and softball. In these training methods, the ball or other projectile will be projected in the general direction of a person wielding an implement such as a bat or racket that is intended to make contact with the projectile. In addition, they may be useful for training in other activities, e.g. for training for goalkeepers in sports such as hockey and lacrosse. While the illustrated embodiment is useful for propelling tennis balls, the invention can be adapted to other balls, such as baseballs, softballs, pickle balls and wiffle balls, and to non-ball projectiles as well.

Further aspects of the ball propulsion apparatus are discussed below. In each of these further aspects, the ball propulsion apparatus operates under the same general principle discussed above for the apparatus shown in Figs. 1 and 2, i.e. delivery of projectiles to a canister and an increase of pressure behind the projectile until sufficient pressure is built up to expel the projectile through the exit tube. The discussion of details of the extension tubes, speed-controlling apertures, position adjusters, spin-imparting members, and support platforms above also applies to these further aspects of the ball propulsion apparatus and is not repeated.

In the ball propulsion apparatus shown in Fig. 6A and B, a pressure canister 64 carries a hopper 66 for holding and delivering balls or other projectiles, e.g. by gravity, to the canister. The hopper carries a cover 68, which houses a blower. The cover can be provided with ventilation holes for the blower if necessary. In one example, the blower can be secured to the hopper, e.g. with bolts or the like extend through the hopper sidewall and/or bottom. In addition or instead, one or mounting brackets can be secured to the hopper, with the blower secured to the mounting bracket(s). The cover also can be secured to the hopper by screws or the like that extend through the sidewall and/or bottom. The blower expels air through outlet 69 to tubing 70, which delivers the air to the canister 64. The tubing can be made of any suitable material, e.g. flexible tubing as is commonly used in pulling a vacuum or other tubing such as pvc tubing, depending on the specific application. Tubing connections can be secured, for example, with automotive hose clamps or the like as needed. The canister 64 is provided with suitable legs or other supports to allow it to sit securely on the ground or on an elevated platform, and these can be made adjustable to ensure a suitable angle and orientation for feeding projectiles from the hopper to the canister. The blower can be, for example, the Ametek Model 117500-12 discussed above, and the apparatus can deliver a tennis ball-sized or baseball-sized projectile at a speed of at least 90 mph (145 kph), preferably at least 100 mph (160 kph) using a single blower that draws no more than 15 amps.

In the ball propulsion apparatus shown in Fig. 7, pressure canister 72 carries a hopper 74. In this case, cover 74 for a blower acts as a support for the canister and hopper. The cover may be of a parallelepiped configuration, although to provide improved stability it might be useful if the bottom of the cover is larger (i.e. covers a

larger area) than the top. The bottom of the cover can be larger in the front-to-back and/or side-to-side direction. It may be desirable to have the top sloped relative to the bottom, i.e. sloping downward from front to back, to help ensure a suitable angle and orientation for feeding projectiles from the hopper to the canister. The canister may be secured to the cover in any suitable manner, for example with the U-shaped (when viewed from the front or rear of the device) member 78, which may be provided with adjustable gripping members such as screw to engage the canister securely. In this case, the blower expels air through an opening in the top of the cover 74, and communicates with the canister by a short pipe, allowing a simple and direct air supply to the canister and improving the balance of the machine.

In the ball propulsion apparatus shown in Fig. 6 and Fig. 7, the blower is outside of the canister. This is advantageous in that it increases the effective volume of the canister. However, providing the blower inside of the canister is possible, as is the case of the apparatus in Figs. 1 and 2.

While a detailed description of the present invention has been provided above, the invention is not limited thereto, and modifications thereto will be apparent. The invention is defined by the following claims.